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(54) IMPROVEMENTS IN AND RELATING TO LOCKS

(71) We, INGERSOLL LOCKS LIMITED, a British Company of Glendale Works, Fernbank Road, Ascot, Berkshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a lock and with particular reference to a plug or similar mechanism suitable for inclusion in a revolving barrel type lock mechanism intended for association with or forming part of a lock.

The present invention provides a key operable barrel lock having

a body;

a detainer carrier rotatable within said body;

a plurality of detainer elements carried by said carrier, each element having a key engaging surface and a notch, a talon juxtaposed said carrier for rotation therewith, said talon being movable to engage said body and bias means acting upon the detainer elements to bias them to a datum position whereby on insertion of an appropriate key and rotation of the same, the key engaging surfaces are picked up to align the notches of the detainers to permit entry of the talon and whereby rotary motion of the key is transmitted to said talon through said detainer carrier.

According to the present invention, there is provided a key operable lock which comprises a body member having a cylindrical bore and a rotatable plug comprising a talon movable between a locking position in which said talon engages said body member to prevent substantial relative rotation of said plug between said plug and said body member and a free position in which said talon is disengaged from said body member to permit said relative rotation, a plurality of detainer elements disposed within said plug and each capable of rotation about the plug axis, each detainer having a key engaging surface and a peripheral notch, the said notch being adapted to accommodate at least part of said talon and being disposed in a fixed angular relationship with said key engaging surface, whereby when the talon is in the locking position, the peripheral notches of the detainer elements are dispersed so that the periphery of at least one of said elements prevents movement of the talon out of engagement with said body member, a carrier for said detainers and spring means biassing said carrier to a datum position, the arrangement being such that on insertion and rotation of an appropriate key, the detainer elements will be engaged by said key on rotation thereof to produce relative rotation between the detainers to align said notches to allow movement of the talon whereupon further rotary motion of said key is transmitted to said carrier to rotate said carrier against said spring bias and the plug with respect to the body member.

With the detainers dispersed in the locked position, that is to say, with the notches and the detainers misaligned, the key engaging surfaces may also be dispersed so that on rotation of the key, lost motion between some of said detainers is taken up until all of the key engaging surfaces are abutting the key whereupon the notches are aligned.

The detainer carrier may comprise a front plate, a back plate and a bridge piece to maintain said front plate and said back plate in spaced parallel relationship. The talon may be a longitudinal member slidable radially of the plug out of and into the aligned notches of the detainer elements. Alternatively, the talon may be a rotatable member having a projection longitudinal of the plug and adjacent thereto whereby said projection may enter into the aligned notches and the talon may move out of engagement with an associated co-operating portion of the body member.

The co-operating portion of the body member may comprise a longitudinal recess in a surface adjacent the plug which recess

is adapted to accommodate a portion of the talon when the talon is disposed in the locking position. The recess may have a chamfered longitudinal cam surface whereby on rotation of the key, the rotation is imparted to said talon by means of the detainer carrier to urge an extremity of the talon against the cam surface to cause the talon to react against the surface and to enter the aligned notches of the plug to permit continued rotation of the plug relative to the body member. In one embodiment of the present invention the talon may be arranged for rotation with the detainer carriage so that rotation of a key from a datum position causes rotation of the plug until the extremity of the talon abuts said cam surface, the rotation of the key permitting the take up of the lost motion provided between some at least of the detainers, thereby permitting alignment of the notches at the periphery thereof. Continued rotation of the key results in presentation of the aligned notch juxtaposed an inner extremity of said talon whereby continued rotation of the key causes the outer extremity of the talon to coact with said cam surface to urge the talon inwardly of the plug thereby permitting continued rotation of the plug relative to the body member.

Alternatively, the talon may be disposed between a pair of spaced longitudinal guides located towards the periphery of the plug and parallel to the longitudinal axis thereof. The guides may serve to support said talon for rotation therewith about the axis of the plug. The guides may be connected to or form part of drive means for connection to a lock device *per se*. The detainer "carrier" may be arranged for rotation about the plug axis in response to rotation of the key about the same axis, and may include a bridge piece adapted to abut an adjacent portion of the talon guide when the notches of the detainers are aligned to receive the talon, whereby continued rotation of the key results in withdrawal of the talon into the aligned notches and out of engagement with said body member.

Each detainer may have an abutment surface adapted to engage with said carrier so that the bias of the carrier to the datum position is applied to the detainers. The bias means may be a spring having an overcentre action to bias the carrier to its datum locked position and to an unlocked position. The spring may be a compression spring.

In another embodiment of the present invention each of the detainers may be spring loaded to a datum position so that on removal of a key applied turning moment each detainer will return to its datum with respect to the detainer carriage. This is in an additional advantage in the lock construction of the present invention since in order to pick the lock, a lock pick having a number of pick elements corresponding to the number of detainers will be required. It will be appreciated, therefore, that where the number of detainers is of the order of ten the problems involved in picking such a lock are immense.

The following is a description by way of example only with reference to the accompanying drawings of embodiments of locks in accordance with the present invention.

Figure 1 is a longitudinal section through a barrel lock assembly in accordance with the present invention;

Figure 2 is a vertical section along the lines 2—2 of Figure 1;

Figure 3 is a front end view of the spring plate assembly at the front end of the lock in Figure 1;

Figure 4 is a rear elevation of the lock of Figure 1;

Figures 5a, 5b, 5c and 5d are details of the detainer carrier of the lock of Figure 1;

Figure 6 is an end elevation of a detainer of the lock of Figure 1;

Figure 7 is an end view of a detainer spacer of Figure 1;

Figure 8 is a side view of a key suitable for use in conjunction with the lock of Figure 1;

Figure 9 is a section illustrating an alternative embodiment of the present invention;

Figure 10 is a part section showing an alternative arrangement of the spring plate assembly for a dead lock;

Figure 11 is a section of a further embodiment of the present invention;

Figure 12 is a detail of Figure 11;

Figure 13 is a detail of a carrier end of the embodiment of Figure 11;

Figures 14a and 14b are details showing the front plate modification of Figure 11;

Figure 15 is a dead lock arrangement for the lock of Figure 11;

Figure 16 is a longitudinal section on another embodiment of the present invention;

Figure 17 is a section on line 17—17 of Figure 16;

Figure 18 is a detail of the spring plate of Figure 16;

Figures 19a and 19b are details showing a detainer for use in the assembly of Figure 16.

Turning now to Figure 1, the lock comprises a cylinder body indicated generally at 10 comprising a cylindrical portion 11 terminating at a forward end in a face piece 12. The cylindrical portion 11 of body 10 has an internal cylindrical bore 13 which is open at its rearward end 14 and terminates at its forward end in an inwardly projecting flange 15. Flange 15 is configured to provide a key aperture 16. The key aperture 16 has a central cylindrical opening 17,

a forward entrance of which is chamfered at 18, adapted to receive the shank of a key. The aperture 16 extends in a radial direction into a rectangular radially disposed bit-accommodating portion 19 (see Figure 2). The face piece 12 is provided with a generally planar forward surface at the extremity thereof and is thereafter convexedly curved towards the radial extremity of the face piece at 20 to terminate in a flange 21 which projects substantially radially outwards of cylindrical portion 11. The rearward edge 21^1 of flange 21 is adapted to abut a surface to which the lock assembly is to be fitted.

The cylindrical body portion 11 is provided with a pair of diametrically spaced outwardly extending screw accommodating portions 22 juxtaposed face piece 12, each of which portions 22 is defined by a longitudinal hemi-cylindrical portion integral with body 11 and accommodating a tapped bore 23 adapted to accommodate connecting screws for securing body 10 to a door element housing the locking assembly.

The cylindrical bore 13 is provided toward its rearward end with an annular recess 24 of generally square cross-section.

The cylindrical portion 11 is provided in its external surface with a longitudinally extending blister 25 symmetrically disposed about a radius of cylindrical bore 13 and in angular spaced relationship with the diameter containing the diametrically disposed screw accommodating portions 22. The inner surface of cylindrical body portion 11 defining cylindrical bore 13 is provided adjacent blister 25 with a corresponding longitudinally extending talon recess 26. Recess 26 is defined by first radial surface 27, an outer surface 28 and a chamfered or cam surface 29, the recess extending in the surface of cylindrical bore 13 rearwardly from face piece 12.

The cylindrical bore 13 of cylindrical portion 11 accommodates a lock cylinder or plug 30 capable of rotation within bore 13 relative to body 10. The cylinder 30 is retained within said bore 13 by means of an annular circlip 31 accommodated within annular recess 24 towards the rearward end 14 of cylindrical bore 13, the arrangement being such that the cylinder 30 is retained within said bore between formed flange 15 and circlip 31. The cylinder 30 comprises towards its rearward end, a plug element 32 including a disc 33 of substantial thickness and a rearwardly extending boss 34. The boss has a diametric slot 35 across its rear surface and terminating in the plane containing the rear face of the disc 33. Disc 33 is counterbored from its forward face to communicate with said slot 35. The outer cylindrical surface of boss 34 is provided, intermediate disc 32 and its rear surface, with a peripheral recess 37 adapted to accommodate a generally toroidal split circlip 38 having a pair of outwardly extending divergent arms 39 whereby the juxtaposition of the abutting portion of the arms 39 may be prised apart by means of a screwdriver or like element, the said juxtaposition being coincident with an open end of the slot 35. A connecting bar 40 having a pair of opposed projections 41 at its forward end is disposed in diametric slot 35 so that the projections 41 are disposed forwardly of circlip 38 to maintain the connecting bar 40 for rotation with the plug element 32. The arrangement of the circlip is such that by prising apart arms 39, one of projections 41 may be hooked over a portion of the retainer disposed across said slot diametrically opposite said arms 39 and the remaining projection 41 may be slipped between the open end of circlip 38 forwardly of the plane containing the same so that on closure of the arms 39 the projections 41 of the connecting bar 40 is trapped by said retainer.

The annular front surface 42 of disc 33 is provided at a periphery thereof with a pair of arcuately spaced guide elements 43 extending forwardly of disc 33. Each guide element is defined by means of an inner arcuate surface 44, an outer arcuate surface 45, a radial surface 46 and a guide surface 47. The guide surfaces 47 of each of guide elements 43 are in spaced parallel relationship one with the other. The outer arcuate surface 45 of each guide element 43 is continuous with the cylindrical periphery of disc 33 of plug element 32.

Forwardly of plug element 32 there is accommodated within the bore 13 a carrier 48. Carrier 48 comprises a front end member 49 of generally disc-shaped configuration, a rear end member 50 also of generally disc-shaped configuration and a bridge element 51 extending between a circumferential part of each said front and said rear end members to maintain said front end member 49 and rear end member 50 in spaced parallel relationship. The said bridge element is of generally arcuate configuration extending through an arc defining an angle of substantially 60° at the axis of bore 13.

The front end member 49 and the rear end member 50 (see Figures 5a and c) are each provided with a key accommodating opening 52 corresponding in form to key aperture 16 in face piece 12 and having a central circular aperture part 53 and a radially disposed rectangular aperture part 54 communicating therewith, the arrangement being such that the circular and rectangular apertures defining the key opening accommodate the shank 108 and bit 109 portions respectively of the key (see Figure 8) suitable for insertion therein. The longitudinal axis of rectangular portion 54 is contained by

the diameter of the disc constituting said front and said rear end members which also contains the radial edge 58 of arcuate bridge element 51.

The peripheral edge 55 of front member 49 is cut away in a portion extending substantially 135° of an arc from the said diameter, the cut away portion being defined by first radial abutment surface 56, and inner arcuate surface 57 and a second radial abutment surface 58 coincident with said diameter containing the longitudinal axis of rectangular portion 54, key opening 52. A notch surface 59 is disposed adjacent said second radial abutment surface 58 and spaced inwardly of the arc defining inner arcuate surface 57; a cam surface 60 extends between notch surface 59 and inner arcuate surface 57 and extends divergently outwards of the radius containing the contiguity of cam surface 60 and notch surface 59. The rear end member 50 has a configuration which is a mirror image of that of the front end member, and the arrangement is such that the cut-away portion defined by said surfaces is adapted to accommodate guide elements 43 of plug element 32 for limited relative rotation therebetween, the arcuate extent of the cut-away portion permitting lost motion between said guide elements 43 and plug element 32 when rotary drive is applied to carrier 48.

The front face 61 of front carrier member 49 carries in spaced arcuate relationship with the rectangular portion 54 of key opening 52 on a side thereof remote from the said cut-away portion a forwardly projecting substantially cylindrical pin 62, the forward portion of which is reduced at 63.

The carrier 48 is arranged to accommodate a plurality, in this embodiment ten, detainers 64 each of which is maintained in spaced parallel relation with an adjacent detainer and/or front and rear members 49 and 50 respectively of carrier 48 by means of spacers 65.

Each detainer 64 (see Figure 6) comprises a generally disc-shaped element 66 having a first cut-away portion 67 and a second cut-away portion 68 in a periphery 69 of disc 65. Each detainer 64 has a key hole 70 comprising a circular portion 71 and a bit accommodating portion 72 corresponding to and adapted to co-operate with the rectangular part of key opening 52 in front and rear end members 49 and 50 respectively of the carrier 48. The bit accommodating part 72 and keyhole 70 is defined by a first surface 73 lying on a chord of the circle containing peripheral edge 69 and a plurality of pick-up steps 74 defined by a first pick-up step 75 which is in spaced parallel relationship with first surface 73, a second pick-up step 76 disposed inwardly of first step 75 and defining a finite angle with said surface 75 to provide an increased dimension of the keyhole between surface 73 and pick-up surface 76, a third pick-up step 77 disposed inwardly of second step 76 and defining an increased angle with first step 75 and a fourth step 78 which is disposed at a still further increased angle with respect to first step 75 and is disposed at a still further increased angle with respect to first step 75 and is disposed inwardly of the surface of third step 77. The arrangement of the pick-up steps 74 is such that insertion of the key into keyhole 70 provides for the bit to be disposed adjacent pick-up steps 74. The bit is then cut or contoured (see Figure 8) and adapted to engage with one of said pick-up steps so that on commencing to turn the key, a bit contoured to engage, say, third pick-up step 77, would take up a certain amount of lost motion before engagement with said step to "pick-up" said detainer whereby different configurations along the bit enables different steps to be picked up on each detainer thereby providing a different degree of lost motion between each detainer on rotation of the key and thereby providing a limited amount of relative rotation between each detainer on rotation of the key.

The first cut-away portion 67 in a peripheral edge 69 of detainer 64 corresponds with the corresponding cut-away portion of the front and rear end members 49 and 50 respectively of the detainer carrier 48. The first cut-away portion is defined by a shoulder 79, an arcuate edge 80 and a step 81, the said step 81 lying on the diameter containing the longitudinal axis of the generally rectangular portion of keyhole 70. Arcuate surface 80 contains an inwardly extending notch 82 of generally square cross-section. The notch in each detainer is in fixed angular relationship with the pick-up step adapted to be engaged by the key, the arrangement being such that on insertion of the key and rotation thereof the detainers will be differentially rotated to align the notches 82 in arcuate edge 80 of each detainer.

The second cut-away portion 68 of each detainer extends from step 81 defining the extremity of the first cut-away portion arcuately above the periphery so that in the datum position of the detainers with respect to the detainer carrier, the radius determining the extremity of the second radial edge 83 will engage the adjacent edge 200 of carrier bridge element 51.

Each of the detainers 64 are spaced apart from each other and the adjacent front end member and rear end member of the carrier 48, by means of spacers 65. Each of spacers 65 is in the general form of a Belleville type washer (see Figure 7), and serves to provide the flexibility necessary to ensure that each spacer imposes sufficient friction

to provide free movement of the detainers and yet to permit each detainer to be rotated independently by the key. Each spacer 65 comprises a keyhole 84 having a circular central portion 85 and a sectoral portion 86 adapted to accommodate the bit of the key during rotational movement of the key to engage the appropriate pick-up steps on the detainers 64. Each spacer is cut-away at a peripheral edge to define a first inner cut-away portion 87 and a second outer cut-away portion 88, the first inner cut-away portion is generally arcuate in form and defined at each end by a radius, the inner arcuate surface of said first cut-away portion incorporates a notch 89, the ends of said inner cut-away portion 87 embracing guide elements 43 of plug 32. The second cut-away portion is a shallower arcuate portion communicating with the first and extends arcuately thereof so that the sum of the first and second cut-away portions corresponds with the extremity of the first and second cut-away portion of each detainer. The extremity of the first cut-away portion 87 of each spacer is arranged so that the first cut-away portion accommodates guide elements 43 of plug element 32, the notch 89 being disposed to correspond with the spaced parallel guide faces 47 of each of elements 43, the arrangement being such that in operation the spacers rotate with the plug element 32 and the detainers 64 rotate relative to the spacers.

Each spacer has one or more radially extending longitudinal blisters 90 and the spacers are manufactured in beryllium/copper or nickel silver alloys and provide a similar function to a Belleville washer.

Forwardly of the detainer carrier 48 there is disposed in bore 13 of body 10 a front plate 91. The front plate 91 is of generally disc-shaped configuration and is adapted for rotation with the key and detainer carrier 48. The front plate 91 is manufactured from sintered carbide or other hardened material and serves to prevent or restrain attack on the locking mechanism by means of drilling. The front plate 91 is provided with a central keyhole of configuration identical to and corresponding with key opening 52 and carrier front end member 49. The arrangement is such that the front plate 91 is contiguous with the front surface of the detainer carrier front end member 49. The front plate has a circular hole adjacent the key opening adapted to receive the thicker shank portion of pin 62 so that in the assembled position the reduced portion 63 of pin 62 projects forwardly of front plate 91, the arrangement being such that the pin engages said front plate 91 for rotation with detainer carrier 48.

The guide elements 43 of plug 32 encompass a generally rectangular talon 92 having a length corresponding to the space between the front face of carrier front end member 49 and of the rear face of carrier rear end member 50, said talon 92 being of longitudinal cross-section and adapted as a sliding fit relative to guide elements 43, and radially of cylinder 30. The talon 92 has planar rectangular surfaces 93 adjacent the guide surfaces 47 and has a convex semi-circular outer surface 94. The inner surface 96 is radiused to correspond with the arcuate edge 80 of first cut-away portion of each diameter. The edge defining the contiguity of one surface 93 and the radiused inner surface 96 is chamfered in each of the portions juxtaposed the carrier front end member 49 and the carrier rear end member 50 for engagement with the cam surface 60 of the cut-away portion of the said members.

The arrangement is such that in the datum position of cylinder 30, the inner arcuate surface 80 of each of the detainers 64 and the corresponding inner arcuate surface 57 of each of the front end member 49 and rear end members 50 of the detainer carrier is disposed adjacent the radiused inner surface 95 of talon 92, and maintains the talon 92 in a position such that it projects from the periphery of the cylinder assembly 30 into talon recess 26.

The space between the front face of front plate 91 and the rear face of inwardly directed flange 15 is occupied by a front spring plate 96 and a rear spring plate 97, the front spring plate 96 being contiguous with the rear surface of flange 15 of body 10 and the rear spring plate being disposed between the front spring plate 96 and front plate 91. Each of the spring plates 96 and 97 (Fig. 3) comprises a generally disc-shaped plate element having a keyhole 99 corresponding to that in the front plate. An arcuate slot 100 extends about the central portion of the keyhole and terminates at a point spaced on either side of said keyhole 99. The width of the slot is sufficient to accommodate the reduced portion 63 of pin 62, the arrangement being such that the pin can pass above the slot to permit the detainer carrier 48 to rotate about the axis of bore 13 with respect to plate element 98. The periphery of plate element 98 is provided with a projection 101 extending outwardly and in the plane thereof and configured to fit into the talon recess 26, the arrangement being such that the projection secures each of spring plates 96 and 97 against rotation with respect to body 10.

The slot 100 accommodates a flexible compression spring 102. A first end of compression spring 102 remote from pin 63 is carried about an arcuate abutment 103 of circular cross-section. The second end of compression spring 102 acts against pin 63 to bias pin 63 and the detainer carrier se-

cured thereto to a datum position at the extremity of slot 100.

A key suitable for use in conjunction with the lock described above is shown in Figure 8 of the accompanying drawings. This key 104 comprises a shank 105 projecting from a finger grip or bow 106. The portion of the shank 107 adjacent bow 106 is in the form of a collar and the major portion of the shank extending from an extremity of the collar is of reduced diameter and serves to define a pin 108. The annular face defined between pin 108 and collar 107 acts to locate the key with respect to the lock on insertion therein. The pin 108 carries a generally planar bit 109 extending radially outwardly of the pin 108, the thickness of bit 109 being substantially uniform. The outer edge 110 is profiled with a plurality of steps each step corresponding to the key engaging surface of a detainer in cylinder 30. The front portion 111 extends to the extremity of edge 110 for the purpose of engaging with front plate 91 and the front end member 49 of detainer carrier 48.

It will be appreciated that the steps in contoured edge 110 of key 104 are adapted to correspond with the first, second, third or fourth steps of the pick-up steps 74 of each detainer 64. The contour of each step in the key bit will relate to the angular spacing between notch 82 and the corresponding pick-up step. The constant angular relationship between the selected step and the notch is maintained so that when the key is turned the notches will be aligned.

In operation, the spring 102 biases pin 63 on the front end member 49 of detainer carrier 48 to abut the adjacent extremity of slot 102, thereby defining a datum position for the assembly. At the same time, radial edge 200 of bridge element 51 abuts radial edge 83 of each detainer to maintain each detainer in its corresponding datum position with shoulder 79 abutting adjacent talon guide 43. In consequence, a peripheral arcuate edge 80 of each detainer 64 is juxtaposed at the radiused inner surface 95 of talon 92 to maintain the talon 92 in the projected position so that the convex outer surface 94 of talon 92 is disposed in talon recess 26. In this position the keyholes in each of the spring plates 96 and 97, the front plate 91, the front end member 49 of detainer carrier 48, each of the detainers 64 and the rear end member 50 of detainer carrier 48 are aligned and maintained in the aligned location by the spring bias applied to pin 63 carried by detainer carrier front end member 49.

The key 104 described above and illustrated in Figure 8 is inserted into the key aperture 16 of the body member 10. Insertion of the key is continued until the annular rear face of collar 107 abuts the front face of front spring plate 96. In this location the bit 109 of key 104 is disposed and accommodated within the keyhole in each of front plate 91, detainer carrier front end member 49, each of detainers 64 and their corresponding spacers 65. The pin projection at the rear of the key enters bore 36 for accommodation therein.

The key 104 is, therefore, supported for rotation above the shank axis by the bore 36 and plug 32 and the spring plates 96 and 97. Rotation of the key in a clockwise direction with respect to Figure 2 produces corresponding movement of the detainer carrier due to coaction between portion 111 of the key bit 108 and the longitudinal walls of rectangular portion 54 of key opening 52 in both detainer carrier front end member 49 and in front plate 91. The initial rotation of the key produces rotation of the carrier with respect to the detainers to remove the radial extremity of bridge piece 51 from its abutting relation with radial edge 83 of each detainer. Continued rotation will bring the extreme portions of the key bit 109 into abutment with the first pick-up step 74 of the detainers contiguous said portion of the key. Thus, the "picked-up" detainers will be caused to rotate under the influence of the key while the portions of the bit of reduced radial extent from the axis of the key shank will not abut a pick-up step and thus some of the detainers will be caused to rotate about the axis of bore 13 with respect to the remainder. Further rotation of the key will produce contact between slightly reduced portions of the key bit and the second pick-up step of the appropriate detainers contiguous said slightly reduced portion, thereby aligning the notches in the secondly picked up detainers with the notches in the firstly picked up detainers. Continued rotation of the key will produce a corresponding pick up of the third pick up step and the fourth pick up step, the arrangement being such that the notches 82 in each detainer will be aligned. Continued rotation will bring second radial abutment surface 58 into abutting relationship with the adjacent talon guide 43 whereby the notched surface 59 in each of detainer carrier front end member 49 and detainer carrier rear end member 50 together with the notches 82 in each of the detainers 64 will be aligned contiguous the radiused inner surface 95 of talon 92. Continued rotation of the key about its axis will produce continued rotation of detainer carrier 48 and will serve to drive the plug 32 about its axis by virtue of the abutment of second radial abutment surface 58 of the detainer carrier against the corresponding surface of the adjacent talon guide 43. The talon 92 is thus urged arcuately about the axis of bore 13 and the convex outer surface 94 of talon 92

is caused to react against cam surface 29 of longitudinal talon recess 26 to urge the talon inwardly of spaced talon guides 43 so that the radiused inner surface 95 enters the aligned notches 82 of each of the detainers. Continued rotation of the key about its axis results in the talon 92 being urged into the notch until the extremity of the convex outer surface 94 of talon 92 is contiguous with or disposed within the peripheral circumference of cylinder 30. The rotational motion of the detainer carrier 48 serves to drive talon guides 43 and hence plug 32 in rotary motion about the plug axis and thus connecting bar 40 is caused to rotate to operate the bolt or latch to the unlocked position in which the pin 63 abuts an extremity of abutment member 103. It will be appreciated that since face plate 91 rotates with detainer carrier 48 and the spring plates 96 and 97 remain stationary, it is not possible to withdraw the key from the lock when the lock assembly is in the unlocked position. Accordingly, in order to withdraw the key, it is necessary to return the key to its datum position (anti-clockwise as viewed in Figure 2) or to release the key whereupon the first radial abutment surface 56 of front end member 49 and rear end member 50 of detainer carrier 48 abut the adjacent talon guide 43 and drive the talon guide and plug towards its datum location. As the spaced guide surfaces 47 approach recess 26 the cam surfaces 60 on each of said front end member 49 and said rear end member 50 act on the radiused portion 95 of the talon 92 to urge the talon outwardly of the cylinder assembly. Continued rotation of the plug 32 and the talon guides 43 under the influence of spring 102 or the return of the key to its datum position causes the talon to be urged outwardly of the plug and into talon recess 26 until the adjacent rectangular surface 93 of talon 92 abuts radial surface 27 of talon recess 26 thereby preventing further rotation of the plug assembly and locating the plug assembly 32 in its datum position. At the same time the spring 102 continues to bias pin 63 towards its datum position at the extremity of slot 100. The notches 82 in the detainer 64 are now free to be dispersed. Lost motion then occurs between the respective detainers 64 until the radial edge 83 is "picked-up" by edge 200 of bridge element 51. Rotation continues until the detainer carrier and each detainer reaches its datum position, in which the shoulder 79 on each detainer abuts the radial surface 46 of talon guide 43.

It will be appreciated that dummy notches of some 10 or 15 thousandths of an inch depression in the periphery of the arcuate edge 80 of each detainer can provide additional hazard against picking of the lock. It is necessary to pick accurately 10 members and at the same time to maintain a bias on the detainer carriage to urge talon 92 to the commencement of cam surface 29. The presence of dummy notches will result in one or more dummy notches being engaged, in which case the only means of releasing the dummy notch is to release the detainer carriage to allow the detainer carrier 48 to return to its datum under the spring bias and to start again.

An alternative embodiment of the present invention is illustrated in Figure 9. In this embodiment the talon guides 43 are secured to and form part of the detainer carrier 48 so that the talon 92 is arranged for rotation with the detainer carrier 48. The talon recess 26 is of substantial arcuate extent, extending over substantially 90 degrees of an arc and extends from a datum defining edge 112 to cam surface 29. The recess 26 defines an arcuate track within which the extremity of talon 92 may move during rotation of the detainer carriage 48 to obtain pick up of the pick up steps 74 of each of detainers 64. The talon is provided with a pair of axially extending projections 113 at each end thereof and the front face of plug element 32 is provided with a track to accommodate the rearwardly projecting element 113 while the spring plates 96 and 97 are provided with a cutaway portion 114 to define a track for the forward projection 113 of talon 92.

In operation of the embodiment, insertion of a key and rotation thereof produces rotation of the detainer carrier 48 and front plate 91 associated therewith about the axis of bore 13 to produce corresponding movement of talon guides 43 and talon 92. Continued rotational movement of the key produces corresponding arcuate movement of the talon within the track defined by recess 26. At the same time pick up of the step 74 of the detainers 64 occurs as before and the notches 82 are aligned as the talon approaches cam surface 29. Continued rotation of the key produces reaction between talon 92 and cam surface 29 to urge the talon inwardly of cylinder 30 to cause projection 113 to enter the track defined by the cut-away portion 114 of each of the spring plates and the corresponding track provided in the front face of plug 32 and by permitting continued rotation of the key until pin 63 engages abutment member 103.

On returning the key to its datum position or allowing the key to return to its datum position under influence of spring loading of compression spring 102, the talon is caused to rotate with the detainer carriage 48 until the extremity of the talon 92 is juxtaposed cam surface 29. Thereupon the projection 113 engage cam surfaces in each of the spring plates and in

the corresponding surface in plug 32 to urge the talon outwardly of cylinder 30.

In the embodiment, illustrated in Figure 10, the spring plate assembly illustrated in Figure 3 may be replaced by a spring plate assembly as illustrated in Figure 10. In this case a toggle spring 115 may be employed, having an end 116 disposed about pin 63. A second end of the toggle spring may contain a hemi-spherical element 117 adapted to abut against and swivel about arcuate portion 118 of the spring recess.

In operation, movement of the pin arcuately within the recess 100^1 results in compression of the spring against hemi-spherical element 118 until the centre point of pin 63 passes "over centre" of arcuate portion 118 with the result that the spring acts to urge pin 63 to the upper extremity of the recess 100, thereby providing an "over centre" arrangement for the lock. In this case a return action has to be provided from the key against the spring loading of pin 63 into the second extremity of recess 100^1 until the pin again passes over the centre, whereupon the spring urges pin 63 to a datum position and a corresponding urge applied to the detainer carriage 48 and detainers carried thereby.

In a further embodiment of the present invention, the detainer carrier may be arranged so that there is lost motion between the key and the detainer carrier until the notches 82 in each of the detainers are aligned.

This embodiment is illustrated in Figures 11 to 15 of the accompanying drawings. In order to achieve this variant of the lock assembly of the present invention, the detainer carrier 48 comprises the carrier front end member 49 and a carrier rear end member 50, the said members being disposed in spaced parallel relationship. The members 49 and 50 are maintained in a spaced parallel relationship by means of spaced talon guide members 43. Each of these members have a configuration corresponding to that described with reference to Figure 1. the front and rear end members 49 and 50 respectively, comprising a disc of material are adapted for a rotational fit in bore 13 of body member 10. The front end member of 49 of detainer carrier 48 has a keyhole 52 comprised by a circular aperture part 53 adapted to accommodate the shank or pin of the key itself and a sector portion 119 which subtends an angle of substantially 90° at or towards the centre of the disc constituting front end member 49, the arrangement being such that the key is free to turn through an angle of substantially 90° without abutting an extremity of key opening 52, thereby providing clearance for key rotation to align the notches 82 in each of detainers 64 prior to commencing turning of the carrier 48. The front face of front end member 49 has a forwardly projecting spigot 120 of circular cross-section, the centre of which lies on a diameter which substantially bisects the angles subtended by the radial extremity of centre portion 119 of the key opening 52. Spigot 120 is disposed so that the cylindrical surface 121 has a common tangent with the periphery of the disc constituting front end member 49.

The detainers and spacers are disposed between front end member 49 and rear end member 50 in a manner described with reference to Figure 1, the configuration of the cut-away portion of each detainer member being such as suitably to accommodate the talon guides 43.

The front plate 91 has a keyhole corresponding to that of the front plate of the assembly described with respect to Figure 1 and adjacent the keyhole a spring drive pin 122 is carried to extend forwardly of the front surface of front plate 91. The portion of the periphery remote from the rectangular portion of the keyhole of front plate 91 is cut-away to define a substantially radial drive face 123, an arcuate surface 124 spaced inwardly of the periphery of the disc defining front plate 91 and a second radial spigot abutment surface 125. The pin 122 is adapted to enter into slot 100 of spring plates 96 and 97 to act in the manner described above.

In operation, the key is inserted into th keyhole with the bit entering the appropriate portion of the hole provided therefor in each of the detainers. The key is thus inserted at the datum position in which the second radial pin abutment surface 125 is in abutting relationship with the spigot 120 of detainer carrier front end member 49. The spring 102 acts on pin 122 to bias said front plate 91 to the datum position. Rotation of the key causes the bit thereof to engage the side of the keyhole in front plate 91 to drive front plate 91 about its axis against the spring bias acting on pin 122. The said portion of keyhole 52 in the detainer carrier front end member 49 allows the key to turn without imparting motion thereto. As progressive rotation of the key produces alignment of the notches 82 in detainers 64 carried by the detainer carrier 48 in the manner described above, when the notches are aligned the drive face 123 of front plate 91 engages the diametrically opposite extremity of spigot 120 on detainer carrier front end member 49. Continued rotation of the key imparts drive to the detainer carrier 48 through spigot 120. In this position the notches 82 are aligned contiguous the radiused inner surface of talon 92 and further rotation of the key causes rotation of talon guides 43 to urge the extremity of the talon against cam sur-

face 29 to permit rotation of the detainer carrier with respect to body 10 to the unlocked position. On return or release of the key the spring 102 urges pin 122 towards its datum position until the talon 92 is juxtaposed talon recess 26, whereupon the talon returns to recess 26 and the detainer carrier 48 is maintained in the stationary position and the pin 122 on front plate 91 is urged to its datum position, whereby the notches 82 in each of the detainers 64 are dispersed and the key can then be withdrawn.

In a modification of the embodiment described, the spring assembly may be modified in a manner shown in Figure 15. The spring plate is provided with a spring support pin 126 carried by the front spring plate 91 which pin 126 carries a leaf spring 127 formed of spring steel. A first end 128 of spring 127 is biased against the cylindrical surface of bore 13 of the body 10. The spring then passes about pin 126 in a coil 129 and the second end 130 is partially cranked at 131 to provide a convex surface which acts against pin 122 to bias it to its datum position. The spring leaf 127 extending across the front surface of front plate 91 over a path shorter than a circumferential path.

In operation, rotation of the key drives front plate 91 in the manner described above. The pin 122 moves against the bias of spring 127 to flex the same against stationary pin 126. Continued rotation of the key results in continued rotation of front plate 91 until pin 122 has urged leaf spring 127 to flex outwardly of a circumferential path contained by the radial extremity of pin 122. At this point the pin 122 rides under the cranked portion 131 of leaf spring 127 and the spring bears against the pin 122 to provide resistance to turning so that the lock may be turned to a dead lock position. Upon returning to the datum position, as the pin 122 passes about the cranked portion 131 of leaf spring 127 the said portion engages the pin and biases the pin towards the datum position in the manner described above.

In a further embodiment of the present invention as set out in Figures 16 to 19 of the accompanying drawings, each of the individual detainers is spring loaded to its datum position. This renders the locks substantially pick proof, and in order to pick the lock it would be necessary to employ a lock picking device having N+1 elements where N is the number of detainers.

In this embodiment (see Figure 17) the talon recess 26 is accommodated within an inwardly raised portion 132 defined by a pair of radial shoulders 133 and 133¹. A plug indicated generally at 32 comprises a plurality of detainer carriers 134 each of which interlocks one with the other, the number of detainer carriers 134 being equal to the number of detainers 64 employed in the assembly. The plug also includes a rear spring plate 135 and a front spring plate 136, a front plate 191 being disposed between front spring plate 136 and the first detainer carrier 134.

Each detainer carrier comprises a disc having a forwardly extending generally annular projection 138 defining a substantially cylindrical depression 139 adapted to carry a detainer 64. Each detainer carrier is provided with a substantially radial slot 140 adapted to accommodate the talon and the opposed faces 141 of slot 140 define the guide surfaces for the talon itself. Juxtaposed on each side of slot 140 there is provided on the front face of each detainer a forwardly extending stud 142 which is adapted to engage with a corresponding recess 143 in the rear face of the preceding detainer carrier element to lock one with respect to the other. An arcuate flange 144 is located on the periphery of disc 137 and extends forwardly of the front forward extremity of the annular projection 138 to mate with a corresponding recess 145 in the rearward surface of the preceding detainer element, the arrangement being such that by interlocking of the projecting parts with the corresponding recesses on the preceding element a detainer carrier can be built up.

The peripheral edge of the detainer carrier elements is cut away at 146 to provide a first shoulder 147 and a second shoulder 148 each of which is adapted to abut shoulders 133 and 133¹ respectively at different attitudes of the detainer carrier.

The keyhole 149 of detainer carrier element 134 is sectored so that the key disposed therein is capable of an arcuate movement through an angle of substantially 90° without corresponding movement of the carrier.

Each detainer carrier element 134 carries a detainer 64 configured and adapted to be accommodated therein. A first detainer projection 151 engages a detainer spring 150 which is biased against the corresponding abutment as part of the thickened portion of the annular projection 138 juxtaposed the talon accommodating slot 140, the arrangement being such as to bias the detainer to its datum position whereby a second abutment surface 152 engages the corresponding surface of the other thickened portion with the forward annular projection 138 of the detainer carrier juxtaposed talon slot 140.

The remainder of the assembly is similar in construction with the embodiments described above. The spring plate illustrated in Figure 18 is provided with a track to accommodate a talon projection in the manner described above, and the spring as-

sembly of the spring plate is also described in detail above.

In operation, insertion of the key with the lock elements in the datum position permits the key to engage the spring plate the front plate and the detainers themselves. Rotation of the key about its axis causes pick-up of the various pick-up steps on the detainers until the notches 82 are aligned for subsequent accommodation of the talon. At the same time, the detainers are rotated about their axis against their spring loading until shoulder 153^1 abuts corresponding third shoulder 153 on the detainer carrier. At this stage the notches 82 are aligned juxtaposed talon 92 and reaction of the extremity of the talon 92 against the cam surface of recess 26 urges the talon inwardly and permits rotation of the composite detainer carrier. Rotation of the detainer carrier elements together with the detainers contained therein and the talon now accommodated within the aligned notches 82 continues until shoulder 148 abuts shoulder 133^1 on the body.

It will be appreciated that the compression spring 102 should be greater in strength than the combined compressed strength of each of the detainer springs 150 so that the drive will not be transmitted to the detainer carrier until the detainers have been partially rotated against their spring bias to align the notches 82 to accommodate the inner portion of the talon 92.

WHAT WE CLAIM IS:—

1. A key operable barrel lock having
a body;
a detainer carrier rotatable within said body;
a plurality of detainer elements carried by said carrier, each element having a key engaging surface and a notch, a talon juxtaposed said carrier for rotation therewith, said talon being movable to engage said body and bias means acting upon the detainer elements to bias them to a datum position whereby on insertion of an appropriate key and rotation of the same, the key engaging surfaces are picked up to align the notches of the detainers to permit entry of the talon and whereby rotary motion of the key is transmitted to said talon through said detainer carrier.

2. A key operable lock which comprises a body member having a cylindrical bore and a rotatable plug comprising a talon movable between a locking position in which said talon engages said body member to prevent substantial relative rotation of said plug between said plug and said body member and a free position in which said talon is disengaged from said body member to permit said relative rotation, a plurality of detainer elements disposed within said plug and each capable of rotation about the plug axis, each detainer having a key engaging surface and a peripheral notch, the said notch being adapted to accommodate at least part of said talon and being disposed in a fixed angular relationship with said key engaging surface whereby when the talon is in the locking position, the peripheral notches of the detainer elements are dispersed so that the periphery of at least one of said elements prevents movement of the talon out of engagement with said body member, a carrier for said detainers and spring means biassing said carrier to a datum position, the arrangement being such that on insertion and rotation of an appropriate key, the detainer elements will be engaged by said key on rotation thereof to produce relative rotation between the detainers to align said notches to allow movement of the talon whereupon further rotary motion of said key is transmitted to said carrier to rotate said carrier against said spring bias and the plug with respect to the body member.

3. A lock as claimed in claim 1 or claim 2 wherein the key engaging surfaces between some of said detainers are dispersed with respect to the others so that on rotation of the key lost motion between some of the detainers is taken up until all of the key engaging surfaces are abutting the key whereupon the notches are aligned.

4. A lock as claimed in any one of the preceding claims, wherein the detainer carrier comprises a front plate, a back plate and a bridge piece to maintain said front plate and said back plate is substantially spaced parallel relationship.

5. A lock as claimed in any one of the preceding claims 2 to 4, wherein the talon is a longitudinal member, slidable radially of the plug, out of and into the aligned notches of the detainer elements.

6. A lock as claimed in any one of Claims 2 to 4, wherein the talon is a rotatable member having a projection longitudinal of the plug and adjacent thereto whereby said projection may enter into the aligned notches and the talon may move out of engagement with an associated co-operating portion of the body member.

7. A lock as claimed in any one of Claims 2 to 6, wherein a co-operating portion of the body member with which the talon engages comprises a longitudinal recess in a surface adjacent the plug, which recess is adapted to accommodate a portion of the talon when the talon is disposed in the locking position.

8. A lock as claimed in Claim 7, wherein the recess has a chamfered longitudinal side defining a cam surface, whereby on rotation of the plug, the rotation is imparted to said talon by means of the detainer

carrier to urge an extremity of the talon against the cam surface thereby causing the talon to react against said surface and to enter the aligned notches of the plug to permit continued rotation of the plug relative to the body member.

9. A lock as claimed in Claim 7, wherein the talon is fixed with respect to the detainer carriage so that rotation of the key from a datum position causes rotation of the plug until the extremity of the talon abuts said cam surface, the rotation of the key simultaneously taking up the lost motion provided between some at least of the detainers to align the notches at the peripheries thereof.

10. A lock as claimed in Claim 7, wherein the talon is disposed between a pair of spaced longitudinal guides located towards the periphery of the plug and parallel to the longitudinal axis thereof.

11. A lock as claimed in Claim 10, wherein the guides serve to support the talon for rotation therewith about the axis of the plug.

12. A lock as claimed in Claim 11, wherein the guides are connected to or form part of the drive means for connection to a bolt or latch *per se*.

13. A lock as claimed in any one of Claims 10 to 12, wherein the detainer carrier has a bridge piece adapted to abut an adjacent portion of the talon guide when the notches of the detainers are aligned to receive the talon whereby continued rotation of the key results in withdrawal of the talon into the aligned notches and out of engagement with said body member.

14. A lock as claimed in any one of the preceding claims wherein each of the detainers is spring loaded to a datum position so that on removal of a key applied turning moment, each detainer will return to its own datum with respect to the detainer carriage.

15. A lock as claimed in any one of the preceding claims wherein each detainer has an abutment surface adapted to engage with said carrier so that the bias of the carrier to the datum position is applied to the detainers.

16. A lock as claimed in any preceding claim wherein the bias means is a spring having an overcentre action to bias the carrier to its datum locked position and to an unlocked position.

17. A lock as claimed in any one of claims 2 to 16 wherein the spring is a compression spring.

18. A lock substantially as herein described with reference to and as illustrated in Figures 1 to 7, 9, 10, 11 to 15 or modified according to Figures 16 to 19 of the accompanying drawings.

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1367356 COMPLETE SPECIFICATION
6 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

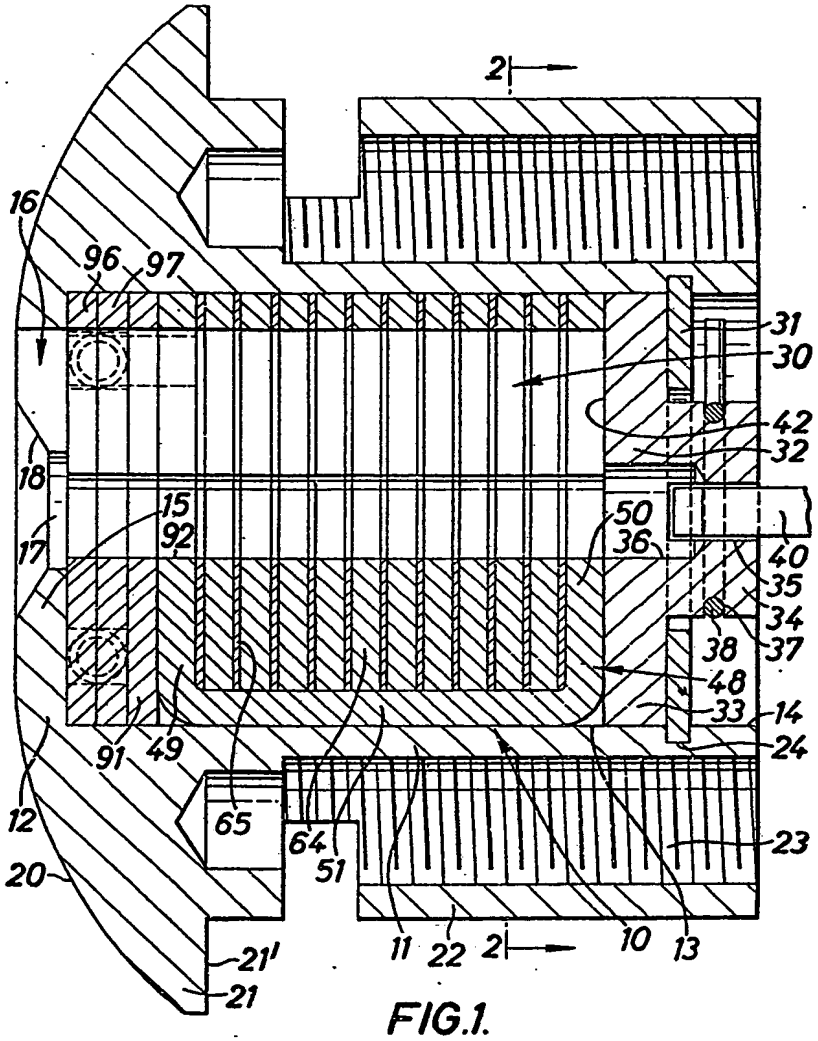

FIG.1.

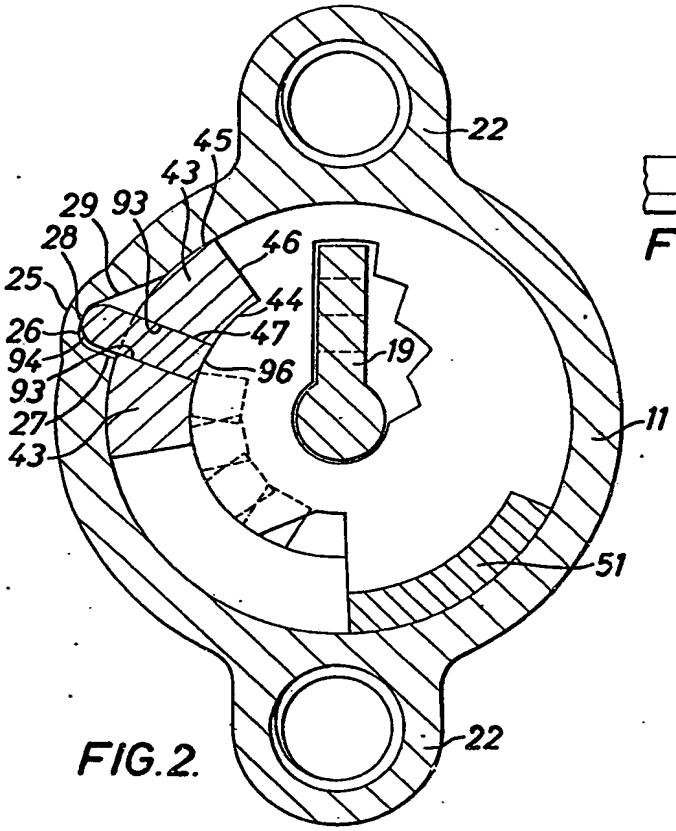

FIG.2.

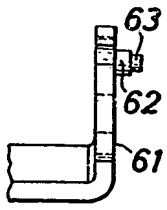

FIG.5d.

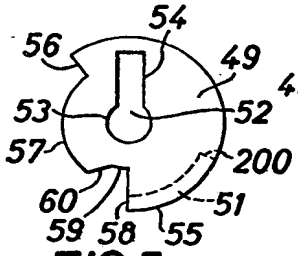

FIG.5a.

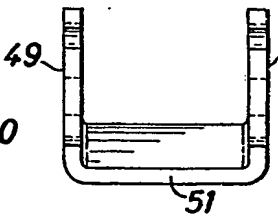

FIG.5b.

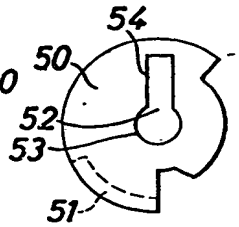

FIG.5c.

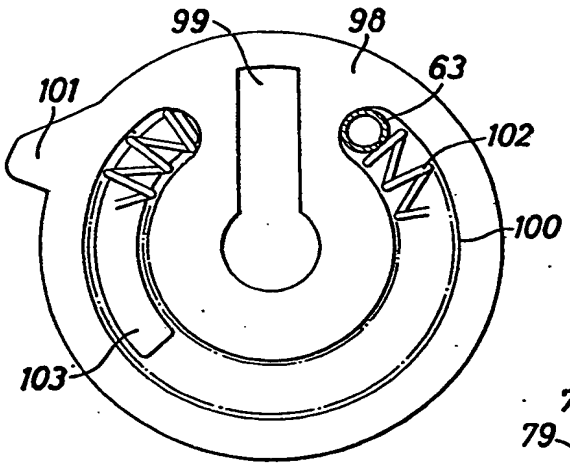

FIG.3.

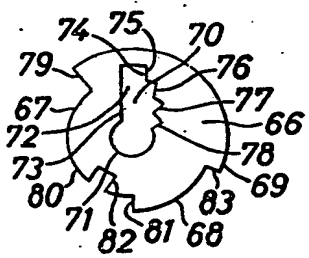

FIG.6.

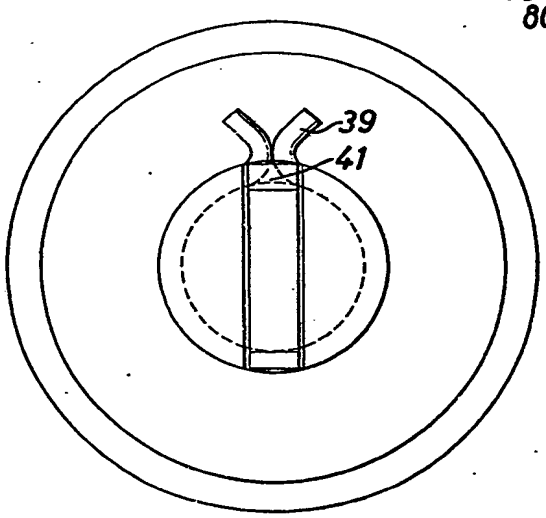

FIG.4.

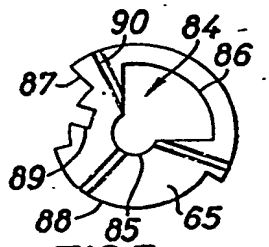

FIG.7.

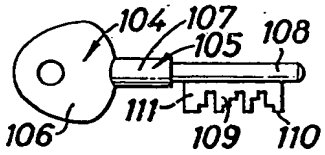

FIG.8.

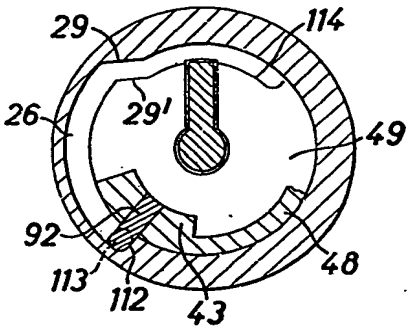

FIG.9.

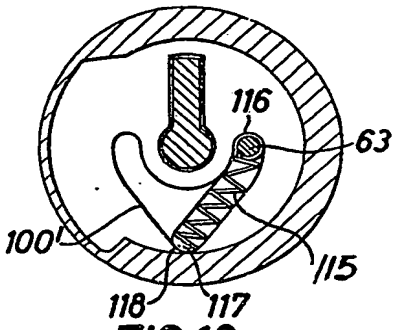

FIG.10.

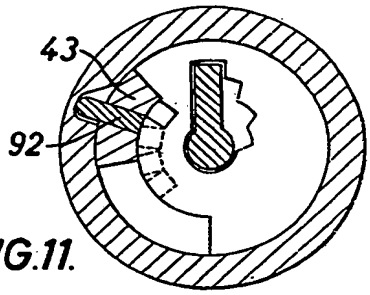

FIG.11.

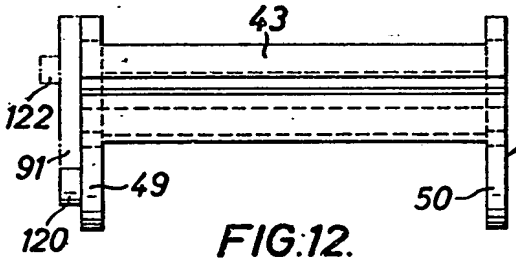

FIG.12.

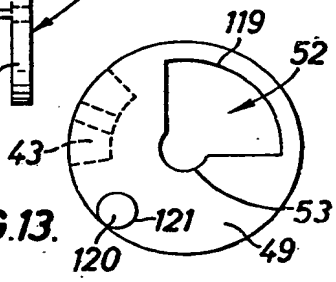

FIG.13.

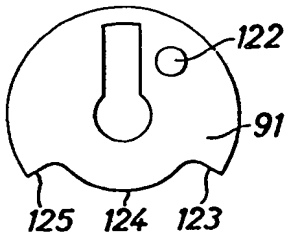

FIG.14a.

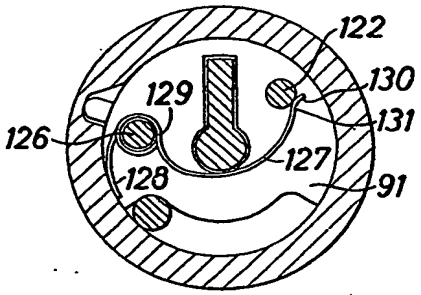

FIG.15.

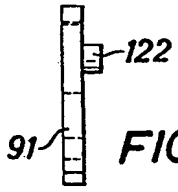

FIG.14b.

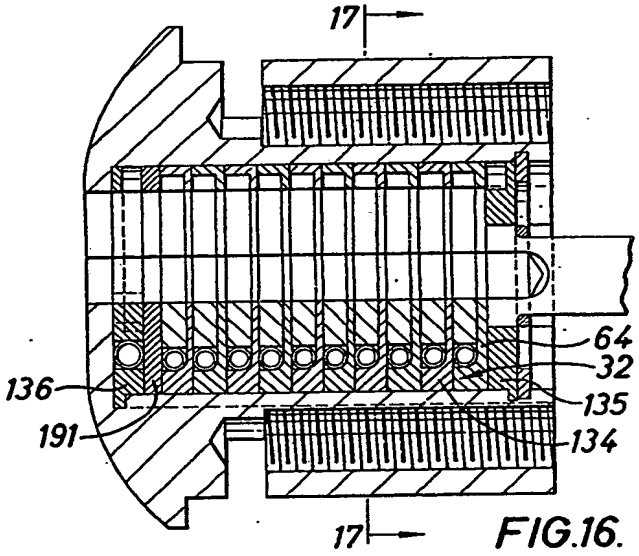

FIG.16.

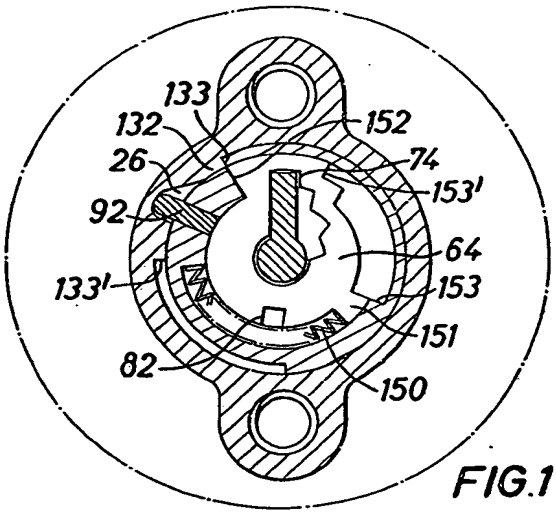

FIG.17.

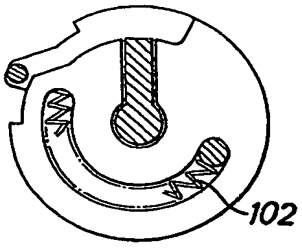

FIG.18.

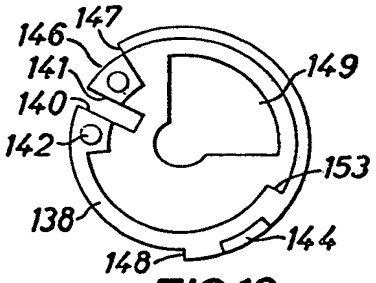

FIG.19a.

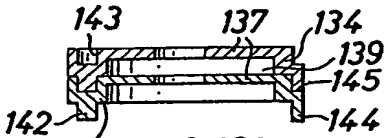

FIG.19b.